



Australian Government
Bureau of Meteorology

Service Level Specification for Flood Forecasting and Warning Services for the Northern Territory – Version 2.0



This document outlines the Service Level Specification for Flood Forecasting and Warning Services provided by the Commonwealth of Australia through the Bureau of Meteorology for the Northern Territory in consultation with the Northern Territory Flood Warning Consultative Committee.

Service Level Specification for Flood Forecasting and Warning Services for the Northern Territory

Published by the Bureau of Meteorology
GPO Box 1289
Melbourne VIC 3001
(03) 9669 4000
www.bom.gov.au

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Cover image: Major flooding on the Katherine River at Nitmiluk Gorge. Photo courtesy of the Northern Territory Department of Land Resource Management. Taken by Sean Lawrie, Senior Hydrographer.

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1 Introduction

- 1.1 The purpose of this Service Level Specification is to document and describe the flood forecasting and warning services provided by the Bureau of Meteorology (the Bureau) in the Northern Territory.
- 1.2 The Bureau's flood forecasting and warning services are provided within the context of the Total Flood Warning System as defined in the Australian Emergency Manuals Series, Manual 21 Flood Warning (Australian Government, 2009 and illustrated in Figure 1).

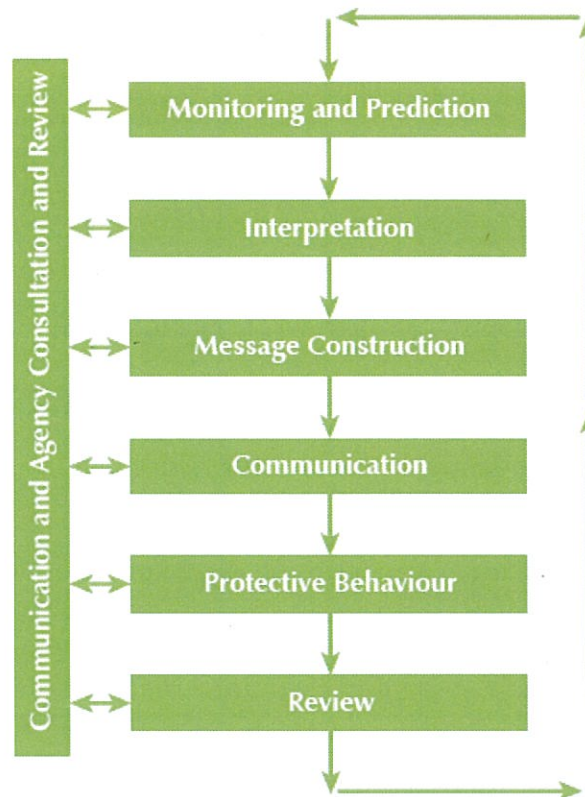


Figure 1: The components of the Total Flood Warning System (Australian Emergency Manual Series, Manual 21 Flood Warning, Australian Government 2009)

- 1.3 The Total Flood Warning System recognises that a fully effective flood warning service is multi-faceted in nature and its development and operation involves input from a number of agencies each with specialised roles to play. It is vital that the agencies involved work in close cooperation through all stages of developing and operating the system. The services described here are the Bureau's contribution to the Total Flood Warning System.
- 1.4 The Bureau's main role in the Total Flood Warning System is focussed on monitoring and prediction, and to a lesser extent interpretation, message construction, and communication components (see Appendix A for descriptions). The Bureau also contributes to the review activities and takes a role in the planning and coordination activities associated with ensuring that the activities of all agencies and appropriate linkages are well coordinated. The roles and responsibilities of all key stakeholders involved in the provision of a flood warning

service in the Northern Territory are described in the National Arrangements for Flood Forecasting and Warning (Bureau of Meteorology, 2015)¹

- 1.5 This Service Level Specification is concerned with describing the Bureau's role in the Total Flood Warning System and its interaction with other stakeholders as described in the National Arrangements. This is to ensure that the service the Bureau is providing in support of each of the relevant components of the Total Flood Warning System is understood by the Bureau and other stakeholders.
- 1.6 A description of the activities that make up the Bureau's flood forecasting and warning services for the Northern Territory is given in Section 3. This set of activities, associated products and target levels of service constitute the current basic service as provided freely by the Bureau. The Bureau also provides supplementary services on a commercial or cost recovery basis but they are not covered in this document.

¹ The National Arrangements for Flood Forecasting and Warning (2015) is available on the Bureau's website: <http://www.bom.gov.au/water/floods/index.shtml>

2 Flood Warning Consultative Committee

- 2.1** The Northern Territory Flood Warning Consultative Committee provides the Bureau's key stakeholders with a consultation mechanism for its flood forecasting and warning services. As such, the committee is responsible for reviewing this Service Level Specification on an annual basis or as required.

- 2.2** The overall role of the Northern Territory Flood Warning Consultative Committee is to coordinate the development and operation of flood forecasting and warning services in the Northern Territory, acting as an advisory body to the Bureau and participating Territory and local government agencies. Membership and terms of reference for this committee in the Northern Territory are detailed in Schedule 1.

- 2.3** The Bureau chairs and provides secretariat support to the Northern Territory Flood Warning Consultative Committee, which meets six monthly depending on need and activity.

3 Bureau flood forecasting and warning services

3.1 The scope of services covered by this Service Level Specification is confined to those dealing with riverine flooding caused by rainfall where typical rain-to-flood times are six hours or more. Flash flooding (rain-to-flood times less than six hours) and flooding caused purely by elevated sea levels are not covered, nor are the weather forecasting and other services the Bureau provides that contribute to the flood forecasting and warning service, including Severe Weather and Severe Thunderstorm Warnings, Tropical Cyclone Warnings, provision of radar data and rainfall forecasts.

3.2 The nature of the services covered by this Service Level Specification include undertaking the routine catchment monitoring and river height prediction activities necessary for the Total Flood Warning System, as well as issuing and publishing specific warning and data products. These activities are listed below with further detail and associated performance measures provided in subsequent sections.

- Collect and publish rainfall and river level data
- Routine monitoring of flood potential
- Flood modelling and prediction
- Automated information and alerting
- Issue flood watches
- Issue flood warnings
- Communication of flood warnings and flood watches
- Data networks, communications and storage
- Operations
- Publishing of data and flood information
- Planning and liaison
- Support for emergency management training and training exercises

3.3 Collect and publish rainfall and river level data

3.3.1 The collection and publishing of rainfall and river level data is an important component of the overall service. Apart from use by the Bureau for data analysis and its hydrological modelling for flood predictions, the data is also used by the emergency service agencies, numerous operational agencies, businesses and the public to monitor rainfall and river conditions. To assist in describing the service, the locations where river height; dam, weir or lake level; and tidal observations are made are categorised into three types; namely forecast location (schedule2), information location (Schedule 3) and data location (Schedule 4).

- **Forecast location** is a location for which the Bureau provides a forecast of future water level either as the class of flood that is predicted (minor, moderate or major) or as a level and class – refer to Appendix A for definitions. At these locations observed data, flood classifications and additional qualifying information will also be available (Schedule 2).
- **Information location** is a location at which flood classifications are defined and observations of water level data are provided. At these locations forecasts of future water level are not produced. Other key thresholds may be defined and reported against (Schedule 3a and 3b).
- **Data location** is a location for which just the observed water level data is provided. Flood classifications are not available for these locations and forecasts of future water level are not produced (Schedule 4).

- 3.3.2** An indicative level of priority has been assigned to each observing site and key communication infrastructure such as radio repeaters (Schedules 2-4 and 7-9) based on a three tiered scheme (Table 1). The priority level is based on the expected impact to the Bureau's services. The impacts identified are the expected outcome of a service outage at that site during a flood emergency. Impact is described in terms of forecast performance and the Bureau's ability to provide a flood warning service. Note that the scope of this priority scheme is limited to consideration of the requirements of forecasting and prediction only and should not be confused with any other priority assigned to that site by third party owners or other users.

Table 1 Site priority

Priority Level	Impact on performance	Impact on service delivery	Description
High	Very difficult to meet target	Direct and significant high level impact for the site and/or downstream locations	Degradation of service highly likely.
Medium	Difficult to meet target	Some impact for the site and/or downstream locations.	Possible degradation of service.
Low	Not likely to affect meeting targets	Little impact on the site and/or downstream location	No change in service. Lower possibility of degradation of service.

Note: Multiple outages within a given network will lead to a higher impact levels and greater service degradation. Table 1 indicates the effect of a single site failure within an otherwise functional network.

3.4 Routine monitoring of flood potential

- 3.4.1** The Bureau will maintain an awareness of catchment conditions and monitor the potential for riverine flooding. This monitoring activity will be supported by the Bureau's weather services as required and is an activity undertaken to plan future flood operations.

3.5 Flood modelling and prediction

- 3.5.1** The Bureau will develop and maintain prediction systems for the forecast locations listed in Schedule 2.
- 3.5.2** The Bureau prediction systems can include real-time hydrologic models, simple peak to peak correlations and other hydrologic techniques as appropriate.
- 3.5.3** The Bureau prediction systems will be maintained and updated following significant events or when new data becomes available.
- 3.5.4** The target level of performance for the prediction at each forecast location is given in Schedule 2.

3.6 Automated information and alerting

- 3.6.1** In the Northern Territory, automated information and alerting is currently provided by the Bureau and the Department of Land Resource Management. For specific details refer to Schedule 3b.

3.7 Issue flood watches

- 3.7.1** The Bureau will issue flood watches when the combination of forecast rainfall and catchment conditions indicates flooding is likely. The catchments and basins covered by flood watches include all those listed in Schedule 10. Note that flood watches may cover catchments that do not have established flood warning services.
- 3.7.2** The primary purpose of a flood watch is to provide early advice to communities and the relevant emergency service organisations of the potential flood threat from a developing weather situation. Typically, a flood watch is issued 1 to 4 days before rain starts depending on the confidence in rainfall forecasts.
- 3.7.3** Flood watches will be communicated by the Bureau using the dissemination methods detailed in Section 3.9.

3.8 Issue flood warnings

- 3.8.1** In general flood warnings are issued based on the following criteria: -
- The river level of at least one forecast location (listed in Schedule 2) is expected to exceed or has exceeded the minor flood level;
 - The flood class levels or trigger heights defined at forecast locations are expected to be exceeded (refer to Schedule 2);
 - The flood class levels defined at information locations are exceeded (refer to Schedule 3).

The specific initiating criteria, if any, for each flood warning product is listed in Schedule 10.

- 3.8.2** Flood warnings may include either **qualitative** or **quantitative** predictions at forecast locations or a statement about future flooding in more **generalised** terms as outlined in Table 2. The type of prediction included is commensurate with user requirements, the availability of real time rainfall and river level data, and the capability of available flood prediction systems. A flood warning may contain **generalised, quantitative and qualitative** predictions and typically start with more **generalised** information and become more specific as data becomes available or the event develops.
- 3.8.3** **Quantitative** predictions include expected flood class (minor, moderate or major) with more specific information on the height and time of water levels at the forecast locations identified in Schedule 2. A **quantitative** prediction can be a specific level or a range of levels, and has detailed timing down to blocks of a minimum of 3-6 hours. **Quantitative** predictions are based on all available information at the time of warning issue. The target lead time of the river height prediction for each forecast location where **quantitative** predictions are provided is given in Schedule 2. For an example of a **quantitative** prediction refer to Table 2.
- 3.8.3.1** For the Bureau to be able to provide a **quantitative** prediction at a location, it is essential to have a suitable network of rainfall and river level sites upstream with data coming in real time, sufficient historical data to calibrate the flood forecasting model, a reliable rating table and documented flood impacts and flood classifications.

- 3.8.4** **Qualitative** predictions include expected flood class (minor, moderate or major) and timing of flooding at the forecast locations identified in Schedule 2. The timing is indicated in blocks of six, 12 or 24 hours, using the terms such as early morning, afternoon or overnight. Such predictions are based on all available information at that time and may include advice on the peak classification that is expected or has occurred at that location. The target lead time for each forecast location where only **qualitative** predictions are provided are given in Schedule 2. For an example of a **qualitative** prediction refer to Table 2.
- 3.8.4.1** For the Bureau to be able to provide a **qualitative** prediction at a location, it is essential to have at least some rainfall and river level sites upstream of the location with data coming in real time, at least some historical flood data to calibrate the flood forecasting model, a reasonable rating table and documented flood impacts and flood classifications.
- 3.8.5** The Bureau may also issue flood warnings with more **generalised** predictions and information when there are not enough data to make specific predictions or in the developing stages of a flood. These warnings contain generalised statements advising that flooding is expected and may include forecast trend (rising or falling) (for examples refer to Table 2).
- 3.8.6** The typical target accuracy of a **quantitative** water level prediction is that 70% are within 0.3 or 0.6 metres of observed water level. Specific accuracy targets by location are defined in Schedule 2. Achievement of these targets is not possible in all floods or at all locations. In general predictions of a flood peak are more accurate than “reach” or “exceed” predictions that are issued during the developing stages of a flood. This is due to uncertainty of future rainfall rates and/or upstream flood behaviour that are used when making those predictions.
- 3.8.7** A list of the flood warnings issued in the Northern Territory, along with the basin/river to which they apply is included in Schedule 10. Details about forecast locations in each basin/river are included in Schedule 2.
- 3.8.8** Flood warning summaries – A summary of flood watches and warnings that are current is provided to help media other users readily access information. This product is currently not issued in the Northern Territory but it is planned to be automated as part of a nationally consistent product set.

Table 2. Prediction type description

Prediction type	Height prediction	Time of prediction	Example
Quantitative	Numerical prediction - Any Height - Peak Height Can refer to flood class	More specific, typically in blocks of 3 to 6 hours	The Daly River at the Daly River Police Station is likely to exceed the Minor Flood Level (4.3 metres) by 3pm Saturday before peaking late Saturday night The Daly River at the Daly River Police Station is expected to peak near 14.1 metres above the major flood level (14.0m) on Sunday afternoon
Qualitative	Refers to flood class (minor, moderate or major)	Range of times (6, 12 or 24 hour blocks)	Minor flooding is expected in the Victoria River at Kalkarindji during Saturday afternoon The Victoria River at Kalkarindji is expected to peak above the Major Flood Level during Sunday evening
Generalised	No height prediction	Range of times (24	Moderate to heavy rainfall has been recorded in

	- forecast trend (rising or falling)	hour blocks)	the headwaters of the Daly River during the past 6 hours. Significant river rises are likely during Saturday the 18 th of December with higher levels possible dependent on further rainfall
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3.9 Communication of flood warnings and flood watches

3.9.1 Flood watches and warnings will be issued directly to a list of stakeholders with emergency management responsibilities. This list is maintained by the Bureau but is not detailed in this document. The direct dissemination methods supported include email, fax and the internet protocols such as File Transfer Protocol (FTP).

3.9.2 The format of messaging in flood related products will conform to a nationally consistent standard determined by the Bureau, in consultation with the Flood Warning Consultative Committee.

3.9.3 Flood watches and warnings are also communicated by the Bureau via:

3.9.3.1 Radio: Radio stations, particularly the ABC, broadcast flood warning information as part of their news bulletins, or whenever practicable. This form of broadcast may be covered in separate agreements between the Bureau and broadcasters.

3.9.3.2 Weather warning service: Flood warning information is recorded on a contracted telephone information service. Calls to this service incur a fee-for-service charge.

3.9.3.3 Internet: Flood watches and warnings are published on the Bureau's public web site and available by File Transfer Protocol (FTP) and Rich Site Summary (RSS) along with related rainfall and river level information (see 3.12).

3.9.4 Emergency management partners² and media can also access flood level and warning information directly from the Bureau Flood Warning Centre and Bureau National Operations Centre, subject to operational constraints. The Bureau does not publish contact details for the Flood Warning Centres and Bureau National Operations Centre.

3.10 Data networks, communications and storage

3.10.1 The services to be provided by the Bureau under this Service Level Specification depend on provision of data from networks of stations owned and operated by the Bureau and partner agencies. Permanent or temporary loss of real time data may necessitate a downgrading of the flood warning service from **quantitative** predictions to **qualitative** or then **generalised**.

3.10.2 The Bureau contribution to this network of stations includes:

- The operation and maintenance of equipment at the sites which are fully owned and maintained by the Bureau as listed in Schedule 7.
- Assisting with maintenance of equipment for other agencies at the sites listed in Schedule 8. The Bureau in the Northern Territory does not currently assist with

² Emergency management partners include those organisations that have an emergency management responsibility for the wider community (e.g. State or Territory Emergency Service)

the maintenance of equipment.

- Operating and maintaining Bureau-owned equipment at sites where this equipment is co-located at a site owned by another agency Schedule 9.

3.10.3 Where the site is owned or operated by other parties, installation, maintenance and repairs of Bureau equipment will depend on adequate access being provided to the Bureau and any of its contractors. The Bureau will confirm access arrangements with relevant land owners before entering the premises. The Bureau also requires that the site operators provide timely advice regarding any possible faults or other issues affecting the performance of the data network.

3.10.4 The flood forecasting and warning service for the Northern Territory also depends on the provision of data from partner agency data networks. The provision of these data for each of the agencies concerned is detailed in a Data Sharing Agreement between the Bureau and each partner (Schedule 6).

3.10.5 The Bureau will maintain the essential set of metadata describing the network of stations and related infrastructure regarding the Bureau's component of the data network, along with metadata required to inform the data ingest process for partner agency related networks and sites.

3.10.6 The Data Sharing Agreements are intended to reflect operational arrangements and are not legally binding and allow multiple agreements between individual and/or multiple agencies.

3.10.7 The parties agree to the provision of data as set out in the Data Sharing Agreements during periods of routine site operation and increased frequency during flood periods.

3.10.8 Data transfer protocols and conditions regarding fitness for purpose as provided by each stakeholder will be adhered to as set out in the Data Sharing Agreements for data provision.

3.10.9 The sharing of data as set out in the Data Sharing Agreements can be amended by following the process described in the agreement.

3.10.10 The Bureau has developed special purpose software (Enviromon) for collecting, alarming, storing, on-forwarding and display of data from Event-Reporting Radio Telemetry Systems (ERRTS) (field equipment) based on Automated Local Evaluation in Real Time (ALERT) data protocol.

3.10.11 The Bureau provides a range of supplementary services associated with Enviromon, including: installation of Enviromon software; the commissioning of an Enviromon base station or maintenance and support; and onsite Enviromon training. However, software licensing and limited support for Enviromon base stations listed in Schedule 5 is currently a standard service (free of charge).

3.11 Operations

3.11.1 The Bureau will use reasonable endeavours to provide a 24 hours a day, seven days a week operational systems capability necessary to support flood warning operations. This will include on-line computer and data ingestion systems, along with appropriate communications infrastructure.

- 3.11.2** The Bureau operates a Flood Warning Centre in each capital city and a Bureau National Operations Centre in Melbourne on an as required basis.
- 3.11.3** Through the regional Flood Warning Centre and Bureau National Operations Centre, the Bureau will provide operational coverage for up to 24 hours per day during flood events, subject to event requirements and operational constraints. The Bureau will advise its key emergency management clients of any impact in services if it is unable to provide sufficient staff coverage to meet the service levels set out in this Service Level Specification (see also 4.2).
- 3.11.4** Staff in the Bureau National Operations Centre will support regional operations either remotely or by providing additional capacity to a regional Flood Warning Centre where reasonably possible during significant and long duration events. When necessary, staff from regional offices in areas not impacted by current flooding will endeavour to assist.
- 3.11.5** The Bureau will maintain an internal catchment directive for each catchment where a warning service is provided. The catchment directive documents and describes the forecast process for the particular catchment and includes flood intelligence information, flood history, contact details for partners with local knowledge and warning issue criteria.
- 3.11.6** The operation of the Flood Warning Centres will endeavour to be compliant with the fatigue management guidelines developed under the Bureau's Work Health and Safety Procedures. Particular attention to fatigue management will be provided during the management of extreme events. The requirement to comply with these guidelines applies to all personnel at these centres.
- 3.11.7** The Bureau will assist in meeting the needs of the Australian Government's National Crisis Coordination Centre. The Bureau will use reasonable endeavours to support and participate in relevant critical event briefings as resources permit.

3.12 Publishing of data and flood information

- 3.12.1** The Bureau will maintain the systems to ingest all data being gathered through the flood warning data network.
- 3.12.2** The river height and rainfall received by the Bureau will be published as soon as practicable (the data are supplied at different frequencies and by various methods) upon receipt into Bureau operational systems. The data will be published in the form of tables, maps and plots and will also be included in warnings and alerting messages and used in modelling systems.
- 3.12.3** Data collected in Bureau systems will be available for use by the Bureau as it requires and for distribution to the public on suitable open source licence terms³.
- 3.12.4** The bureau will continue to collect and update the flood background information contained on its website. These include survey information, flood history and flood event reports, catchment maps and brochures.

³ Please refer to the Creative Commons License:
<http://www.bom.gov.au/water/regulations/dataLicensing/ccLicense.shtml>

3.13 Planning and liaison

- 3.13.1 The Bureau undertakes a range of routine planning, maintenance and liaison activities that support the Total Flood Warning System. This includes contributing to related flood risk management activities within the State or Territory impacting on, or related to flood warning along with the ongoing coordination and liaison activities essential to the smooth operation of the Total Flood Warning System.

3.14 Support for emergency management training and exercises

- 3.14.1 The Bureau will, within operational constraints, endeavour to support and participate in relevant disaster management activities outside of flood operational periods, including training exercises and flood response planning.

4 Level of service and performance reporting

- 4.1** Achievable levels of service provided by the Bureau are dependent on many factors including adequate access to Bureau equipment where located on sites owned by other agencies, data availability in near real time from Bureau and partner agencies, modelling and prediction capability, geomorphology of the catchment and meteorological considerations such as rainfall patterns.
- 4.2** If during a flood event the achievable service level is expected to be reduced, for any reason below the target level as stated in this Service Level Specification, the Bureau will inform the key emergency management clients in the Northern Territory of the reduced service level via email and phone.
- 4.3** The Bureau's performance during significant events will be reviewed and reported on using a standard performance structure developed in conjunction with key stakeholders and within the context of the Total Flood Warning System based on key performance indicators and the service levels defined in Schedule 2.
- 4.4** An annual performance report will be tabled at a Flood Warning Consultative Committee meeting if significant flooding has occurred in the previous year. This report may be published on the Bureau website.
- 4.5** Event based performance reports with more detailed technical information may also be produced for significant and high profile events.

5 Limitations of service

5.1 Performance of services provided under this document are subject to:

- (a) The availability of funds and human resources of the Bureau and its partner agencies and changes to organisational policies that may affect the terms and conditions of the Service Level Specification.
- (b) Circumstances beyond the control of the Bureau including where the performance is the responsibility of another entity.
- (c) The existence of a reliable and ongoing supply of quality real time rainfall, water level and flow data.
- (d) The reliable and ongoing availability of the computing and communication infrastructure required for the performance of the services.
- (e) Adequate communication between the Bureau and all relevant partners under this Service Level Specification and related Data Sharing Agreements and any other agreement relevant to it including on any faults or issues.

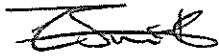
5.2 This Service Level Specification does not replace or reduce the value of any State or Territory arrangement document that may exist.

6 Service Level Specification consultation, review and updating

- 6.1** The initial and annual process for acceptance of this Service Level Specification will be:
- 6.1.1** The Flood Warning Consultative Committee members will be provided with the draft or amended Service Level Specification in advance of a special or scheduled committee meeting.
 - 6.1.2** The members of the Flood Warning Consultative Committee will distribute the draft or amended Service Level Specification within their organisations and provide feedback from their organisation at the committee meeting.
 - 6.1.3** After consultation and discussion at the Flood Warning Consultative Committee meeting, the Bureau will update the Service Level Specification.
 - 6.1.4** The Chair of the Flood Warning Consultative Committee (Bureau's Regional Director) will accept and sign the document on behalf of the committee.
 - 6.1.5** The Assistant Director Water Forecasting Services will sign the Service Level Specification on behalf of the Director of Meteorology.
 - 6.1.6** The Bureau will then distribute the Service Level Specification to all members of the Flood Warning Consultative Committee and publish a copy on the Bureau website.
- 6.2** The schedules of this Service Level Specification will be reviewed annually and either updated following review, or when a significant change is made that impacts on the level of services described in this document. Updates to this document will be recorded in Schedule 11.
- 6.3** Any changes to the categorisation of a location into data, information or forecast location or to the level of services described in this document will be through a consultative process using agreed arrangements in the Northern Territory and when required coordinated by the Flood Warning Consultative Committee.

7 Signature of parties

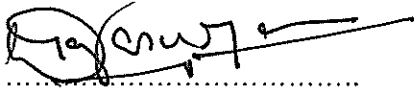
7.1 This Service Level Specification has been prepared by the Bureau of Meteorology in consultation with the Northern Territory Flood Warning Consultative Committee.



.....
Mr Todd Smith
Chair of the Northern Territory Flood Warning Consultative
Committee, and Regional Director – Northern Territory
Bureau of Meteorology

3 NOVEMBER 2015

.....
Date



.....
Dr Dasarath (Jaya) Jayasuriya
Assistant Director
Water Forecasting Services
Bureau of Meteorology

16 Nov '15

.....
Date

Schedule 1: Flood Warning Consultative Committee

The Northern Territory Flood Warning Consultative Committee (FWCC) was formed in 1988. The Committee's role is to coordinate the development and operations of the Territory's flood forecasting and warning services. It is an advisory body and reports to the Bureau of Meteorology and participating state and local government agencies twice each year. The membership includes

- Bureau of Meteorology (Chair/Secretariat)
- Northern Territory Emergency Service
- Northern Territory Department of Land Resource Management
- Local Government Association of Northern Territory
- Northern Territory Department of the Chief Minister (Security and Emergency Recovery)

The nationally consistent Terms of Reference for Flood Warning Consultative Committees are:

1. Identify requirements and review requests for new and upgraded forecasting and warning services
2. Establish the priorities for the requirements that have been identified using risk based analyses of the Total Flood Warning System.
3. Review and provide feedback on the Service Level Specification for the Bureau's Flood Forecasting and Warning services on an annual basis
4. Coordinate the implementation of flood warning systems in accordance with appropriate standards.
5. Promote effective means of communication of flood warning information to the affected communities
6. Monitor and review the performance of flood forecasting and warning services.
7. Build awareness and promote the Total Flood Warning System concept.

Service Level Specification for Flood Forecasting and Warning Services for the Northern Territory

Schedule 2: Forecast locations and levels of service

Column definitions:

Bureau number: Refers to the unique number assigned to a particular station by the Bureau

Forecast location: Is the specific location that will be referred to in flood warnings (refer 3.3.1)

Station owner: Refers to the owning and operating agency of the station. The Bureau may co-own stations. (refer Schedules 7 and 8)

Gauge type: Either manual (read by human) or automatic (consisting of either ALERT or telemeter gauges)

Flood classification: For definitions please refer to Appendix A.2.

Prediction type: The type of warning service that particular location can expect. (refer 3.8)

Target warning lead time: The minimum lead time that will be provided before the height or the flood class level given is exceeded (refer 3.8)

Target peak accuracy: The error within which peak river level height is predicted (refer 3.8.7)

Bureau number	Forecast location	Station owner	Gauge type	Flood classification (m)			Prediction type	Target warning lead time		70% of peak forecasts within	Priority
				Minor	Moderate	Major		Time (hrs)	Trigger height (m)		
817 – Adelaide River											
514059	Adelaide River Town	Department of Land Resource Management	Automatic	11.5	11.9	12.3	Quantitative	6	11.9	+/- 0.3	High
814 – Daly River											
514910	Daly River Police Station	Department of Land Resource Management	Automatic	12.6	13.1	14.0	Quantitative	72	13.1	+/- 0.3	High
814 – Katherine River											
514916	Nitmiluk Centre: Gorge Road	Department of Land Resource Management	Automatic	3.0	5.5	6.5	Quantitative	12	5.5	+/- 0.3	High

Service Level Specification for Flood Forecasting and Warning Services for the Northern Territory

Bureau number	Forecast location	Station owner	Gauge type	Flood classification (m)			Prediction type	Target warning lead time		70% of peak forecasts within	Priority
				Minor	Moderate	Major		Time (hrs)	Trigger height (m)		
814 – Katherine River (continued)											
514916	Nitmiluk Centre: Katherine	Department of Land Resource Management	Automatic	5.5	6.5	8.0	Quantitative	6	6.5	+/- 0.3	High
903 – Roper River											
514603	Beswick Bridge	Department of Land Resource Management	Automatic	7.7	8.1	8.3	Quantitative	12	8.1	+/- 0.3	High
811 – Victoria River											
514824	Kalkarindji	Department of Land Resource Management	Automatic	9.0	11.0	14.0	Qualitative	8	11.0	+/- 0.6	High
907 – McArthur River											
514700	McArthur River Borroloola	Department of Land Resource Management	Automatic	9.0	13.7	14.9	Qualitative	12	13.7	+/- 0.6	High

Notes:

- All levels are in metres to local gauge datums unless indicated otherwise.
- AHD - Australian Height Datum. See [Geoscience Australia](#) for further information.

Schedule 3a: Information locations with flood class levels defined

Bureau number	Station name	Station owner	Gauge type	Flood classification (m)			Priority
				Minor	Moderate	Major	
817 – Adelaide River							
514003	Adelaide River Arnhem Highway	Department of Land Resource Management	Automatic	n/a	n/a	n/a	Medium
814 – Daly River							
514909	Beeboom Crossing	Department of Land Resource Management	Automatic	n/a	n/a	n/a	High
514206	Cullen River	Department of Land Resource Management	Automatic	n/a	n/a	n/a	Medium
514912	Doritsvale Crossing	Department of Land Resource Management	Automatic	n/a	n/a	n/a	Medium
514913	Katherine Bridge	Department of Land Resource Management	Automatic	15.5	16.5	18.0	High
815 – Finniss River							
514192	Elizabeth River	Department of Land Resource Management	Automatic	n/a	n/a	n/a	Medium
514008	Rapid Creek	Department of Land Resource Management	Automatic	3.0	3.2	3.4	High
903 – Roper River							
514606	Warlock Ponds	Department of Land Resource Management	Automatic	n/a	n/a	n/a	Low
006 – Todd River							
515003	Anzac Oval	Department of Land Resource Management	Automatic	2.0	2.77	3.5	High
515004	Wigley Gorge	Department of Land Resource Management	Automatic	2.0	3.0	5.5	High
811 – Victoria River							
514821	Coolibah	Department of Land Resource Management	Automatic	n/a	n/a	n/a	Low
514822	Dashwood Crossing	Department of Land Resource Management	Automatic	n/a	n/a	n/a	Medium
514826	Victoria River Crossing	Department of Land Resource Management	Automatic	n/a	n/a	n/a	High
514823	Williams Crossing	Department of Land Resource Management	Automatic	n/a	n/a	n/a	Medium

Notes:

- All levels are in metres to local gauge datums unless indicated otherwise.
- All flow rates are in cubic metres per second (m³/sec) unless indicated otherwise.
- n/a: Flood classification levels do not exist. Sites are information locations as they give information in relation to bridge or crossing levels.
- All levels indicate flooding in the local reaches of the stream.
- AHD - Australian Height Datum. See Geoscience Australia for further information.

Schedule 3b: River and rainfall alert conditions

DLRM number	Bureau number	Site name	Issuing agency	Alert	Watch point	Minor alarm	Moderate alarm	Major alarm	Priority
006 – Todd River									
G0060046	515004	Todd R at Wigley Gorge	Department of Land Resource Management Bureau	-	1.0#^	-	-	-	High
G0060046	515004	Todd R at Wigley Gorge	Department of Land Resource Management Bureau	-	-	-	4.0*	-	High
G0060047	515005	Charles R at Big Dipper	Department of Land Resource Management Bureau	-	1.0#^	-	-	-	High
G0060047	515005	Charles R at Big Dipper	Department of Land Resource Management Bureau	-	-	-	4.0*	-	High
G0060009	515003	Todd R at Anzac Oval	Department of Land Resource Management Bureau	-	1.2#^	-	-	-	High
G0060009	515003	Todd R at Anzac Oval	Department of Land Resource Management Bureau	-	-	-	2.7*	-	High
G8110016	514824	Victoria R at Kalkarindji	Department of Land Resource Management	-	8.0#^*	-	11.0^*	-	High
G8110232	514823	Wickham R at Williams Crossing	Department of Land Resource Management	-	7.0^	-	9.0#^	-	Medium
G8110113	514822	Victoria R at Dashwood Crossing	Department of Land Resource Management	-	8.7^	-	13.0^	-	Medium
G8110018	514826	Victoria R at Victoria R Crossing	Department of Land Resource Management	-	-	-	17.0^	-	High
G8110007	514821	Victoria R at Coolbah station	Department of Land Resource Management	-	-	-	12.0^	-	Low
G8140219	514915	Katherine R near Birdie Ck	Department of Land Resource Management	-	5.5^	-	7.0^	-	Medium
G8140159	514917	Seventeen Mile Creek	Department of Land Resource Management	-	4.5^	-	6.0^	-	High
G8140022	514916	Katherine R at Nitmiluk Centre	Department of Land Resource Management Bureau	2.9#	5.3#^*	-	6.3^*	7.8^*	High
G8140022	514916	Katherine R at Nitmiluk Centre	Department of Land Resource Management Bureau	2.9*	-	5.4*	6.4*	7.8*	High
G8140001	514913	Katherine R at Katherine Bridge	Department of Land Resource Management Bureau	-	15.5^*	-	-	-	High
G8140001	514913	Katherine R at Katherine Bridge	Department of Land Resource Management Bureau	-	16.0*	16.5*	17.5*	18.5*	High
G8140157	514050	Fergusson R near Bondi Ck	Department of Land Resource Management	-	-	-	-	-	Medium
G8140067	514912	Daly R at Dorisvale Crossing	Department of Land Resource Management	-	13.0^	-	-	18.0^	Medium
G8140042	514909	Daly R at Beeboom Crossing	Department of Land Resource Management	-	12.0^*	-	14.0*	16.0^	High
G8140063	514900	Douglas River at Douglas Crossing	Department of Land Resource Management	-	8.0^*	-	-	-	Medium
G8140098	514902	Daly R at Theyona Station	Department of Land Resource Management	-	-	-	-	-	Medium
G8140040	514911	Daly R at Mount Nancar	Department of Land Resource Management	-	13.0^*	-	15.2*	15.9^	High
G8140003	514910	Daly R at Daly R Police Station.	Department of Land Resource Management	-	12.0#^*	12.5*	13.1*	14.0^*	High
G8150127	514008	Rapid Creek	Department of Land Resource Management	-	2.6#^	2.8#	3.0#^	3.2#^	High
G8170008	514019	Adelaide R East Branch	Department of Land Resource Management Bureau	-	5.0^*	-	-	-	High
G8170008	514019	Adelaide R East Branch	Department of Land Resource Management Bureau	-	5.0*	-	8.0*	-	High
G8170094	514017	Adelaide R West Branch	Department of Land Resource Management Bureau	-	6.5^*	-	-	-	High
G8170094	514017	Adelaide R West Branch	Department of Land Resource Management Bureau	-	6.5*	-	10.0*	-	High
G8170002	514059	Adelaide R at Adelaide River Town	Department of Land Resource Management	-	9.0#^*	11.5^*	-	-	High

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DLRM number	Bureau number	Site name	Issuing agency	Alert	Watch point	Minor alarm	Moderate alarm	Major alarm	Priority
G9030514	514603	Waterhouse R d/s Dijin Hill	Department of Land Resource Management	-	-	-	-	-	Medium
G9030089	514603	Waterhouse R at Beswick Bridge	Department of Land Resource Management	-	6.0#^*	7.7^*	-	-	High
G9030176	514604	Roper R d/s Mataranka	Department of Land Resource Management	-	-	-	8.0^	-	Medium
G9030001	514606	Eisey Ck at Warlock Ponds	Department of Land Resource Management	-	-	4.5^	-	-	Low
G9070121	514700	McArthur R at Borrooloola Crossing	Department of Land Resource Management	-	-	9.0#^*	13.6*	-	High

Notes:

- Recipients: #: NTES Duty Officer, ^: DLRM Duty Officer, * BOM Duty Officer
- - Refers to no alarm being sent

Schedule 4: River data locations

Bureau number	Station name	Owner	Gauge type	Priority
817 – Adelaide River				
514019	Adelaide River East	Department of Land Resource Management	Automatic	High
514017	Adelaide River West	Department of Land Resource Management	Automatic	High
814 – Katherine River				
514915	Birdie Creek	Department of Land Resource Management	Automatic	Medium
514900	Douglas River GS	Department of Land Resource Management	Automatic	Medium
514921	Dry River GS	Department of Land Resource Management	Automatic	Low
514905	Edith River	Department of Land Resource Management	Automatic	Low
514050	Fergusson River	Department of Land Resource Management	Automatic	Medium
514901	Fergusson River Railway Bridge	Department of Land Resource Management	Automatic	Low
514060	Flora River Kathleen Falls	Department of Land Resource Management	Automatic	Low
514914	Flora River Stoney Creek	Department of Land Resource Management	Automatic	Low
514305	Gourley	Department of Land Resource Management	Automatic	Medium
514918	Ironwood Station	Department of Land Resource Management	Automatic	Medium
514920	King River Stuart Highway	Department of Land Resource Management	Automatic	Low
514600	King River Victoria Highway	Department of Land Resource Management	Automatic	Low
514911	Mount Nancar	Department of Land Resource Management	Automatic	High
514917	Seventeen Mile Creek	Department of Land Resource Management	Automatic	High
514902	Theyona Station	Department of Land Resource Management	Automatic	Medium
907 – McArthur River				
514705	Baileys Grave	Department of Land Resource Management	Automatic	Medium
514702	McArthur River MRM	Department of Land Resource Management	Automatic	Medium
903 – Roper River				
514608	Diljin Hill	Department of Land Resource Management	Automatic	Medium
514604	Roper River Mataranka	Department of Land Resource Management	Automatic	Medium
006 – Todd River				
515005	Big Dipper	Department of Land Resource Management	Automatic	High
515501	Heavitree Gap GS	Department of Land Resource Management	Automatic	High

Notes:

- Data from MANUAL stations are not available in (near) real time.

Schedule 5: Enviromon base stations installed in the Northern Territory

Owner	City/Town	License No	Number of Users	Date of Registration	License Version
Bureau of Meteorology	Darwin	61080001	10	19/10/2004	3
		61080011	10	19/10/2004	3
Northern Territory Department of Land Resource Management	Alice Springs	61080006	3	11/02/2004	3
		61080007	3	20/10/2004	3
	Palmerston	61080017	3	19/09/2012	3

Schedule 6: List of Data Sharing Agreements for data provision

A Data Sharing Agreement for data provision has been set up or is in development for the following agencies.

Agency	Status	Date of completion	Number of sites
NT Department of Land Resource Management	Complete	May 2014	41

Schedule 7: List of sites owned and maintained by the Bureau

Bureau number	Station name	Gauge type	Data type	Priority
817 – Adelaide River				
14052	Adelaide River Ridge	Automatic	Repeater only	High
14055	Upper Adelaide River	Automatic	Rainfall	High
814 – Daly River				
14062	Edith Falls Ridge	Automatic	Rainfall	Medium
14942	Eva Valley	Automatic	Rainfall	High
14970	Fanny Creek	Automatic	Rainfall	High
14906	Fish River	Automatic	Rainfall	Medium
14059	Foelsche Headland	Automatic	Rainfall	High
14971	Katherine Police Station	Automatic	Base Station	High
14950	Mount Felix	Automatic	Rainfall	High
14972	Mount Stow	Automatic	Rainfall	High
14966	Nitmiluk Ridge	Automatic	Rainfall	Medium
14204	The Pines	Automatic	Rainfall	High
14968	Tindal Radar	Automatic	Base Station	Medium
14947	Upper Fergusson River	Automatic	Rainfall	High
14965	Upper Seventeen Mile Creek	Automatic	Rainfall	Medium
14224	Wandie Creek	Automatic	Rainfall	High
14962	Yeuralba Ridge	Automatic	Rainfall	Medium
815 – Finniss River				
14002	Berrimah Radar	Automatic	Base Station	High
14022	Darwin River Ridge	Automatic	Repeater only	High
14144	Marrara	Automatic	Rainfall	Medium
14112	Nightcliff Pool	Automatic	Rainfall	Medium
260044	NT Regional Office	Automatic	Repeater only	Medium
14141	Pinelands	Automatic	Rainfall	Medium
14167	Stokes Hill	Automatic	Rainfall	Medium
14070	The Chase	Automatic	Rainfall	Medium
907 – McArthur River				
14306	Merlin Mine	Automatic	Rainfall	High
903 – Roper River				
14654	Central Waterhouse	Automatic	Rainfall	High
14653	Conways	Automatic	Rainfall	Medium
14652	Maranboy Hill	Automatic	Rainfall	Medium
14651	Snowdrop Creek	Automatic	Rainfall	High
14730	Upper Waterhouse River	Automatic	Rainfall	High
14648	West Waterhouse	Automatic	Rainfall	High
006 – Todd River				
15590	Alice Springs Airport	Automatic	Base Station	High
811 – Victoria River				
14816	Old Delamere	Automatic	Rainfall	Low
14828	Shoeing Tool Bore	Automatic	Rainfall	Low
14854	Sunshine Bore	Automatic	Rainfall	High
14866	Upper Victoria River	Automatic	Rainfall	High
14867	Upper Wickham River	Automatic	Rainfall	Low

Notes:

- Does not include daily rainfall, automatic weather stations and other Bureau synoptic stations.

Schedule 8: List of sites where the Bureau assists other agencies with maintenance

Bureau number	Station name	Owner	Gauge type	Data type	Priority
NIL	NIL	NIL	NIL	NIL	NIL

Notes:

- The Bureau does not currently assist any other agencies with maintenance in the Northern Territory.
- Does not include daily rainfall, automatic weather stations and other Bureau synoptic stations.

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Schedule 9: List of sites where the Bureau co-locates equipment and the site is owned by another agency

Bureau number	Station name	Owner	Gauge type	Data type	Priority
14022	Darwin River Ridge	PowerWater	Automatic	Repeater	High
14144	Marrara	Department Land Resource Management	Automatic	Rainfall	Medium
14112	Nightcliff Pool	Darwin City Council	Automatic	Rainfall	Medium
14070	The Chase	Department Land Resource Management	Automatic	Rainfall	Medium
14062	Edith Falls Ridge	Parks and Wildlife Commission NT	Automatic	Rainfall	Medium
14971	Katherine Police Station	Northern Territory Police Fire and Emergency Service	Automatic	Base Station	High
14966	Nitmiluk Ridge	Parks and Wildlife Commission NT	Automatic	Rainfall	Medium

Notes:

- Does not include daily rainfall, automatic weather stations and other Bureau synoptic stations.

Schedule 10: List of flood warning related products issued by the Bureau in the Northern Territory (warnings, watches, bulletins, river alerts)

Flood warnings

Product ID	Product name	Initiating criteria		Updated	Finalising
IDD20535	Adelaide River	To be issued when minor flood levels are expected to be exceeded at Adelaide River Town (514059).	Minor Moderate Major	12 hourly 6 hourly 3-6 hourly	Final warning to be issued when water level is falling to minor flood level and no further upstream rises are expected.
IDD20545	Daly River	To be issued when minor flood levels are expected to be exceeded at Daly River Police Station (514910).	Minor Moderate Major	12 hourly 8 hourly 6-8 hourly	Final warning to be issued when water level is falling to minor flood level and no further upstream rises are expected.
IDD20555	Katherine River	To be issued when minor flood levels are expected to be exceeded at Nitmiluk Centre (514916).	Minor Moderate Major	12 hourly 6 hourly 3-6 hourly	Final warning to be issued when water level is falling to minor flood level and no further upstream rises are expected.
IDD20565	Waterhouse River	To be issued when minor flood levels are expected to be exceeded at Beswick Bridge (514603).	Minor Moderate Major	12 hourly 6 hourly 3-6 hourly	Final warning to be issued when water level is falling to minor flood level and no further upstream rises are expected.
IDD20575	Victoria River	To be issued when minor flood levels are expected to be exceeded at Kalkarindji (514824).	Minor Moderate Major	12 hourly 6 hourly 3-6 hourly	Final warning to be issued when water level is falling to minor flood level and no further upstream rises are expected.
IDD20585	McArthur River	To be issued when minor flood levels are expected to be exceeded at McArthur River Borroloola (514700).	Minor Moderate Major	12 hourly 8 hourly 6-8 hourly	Final warning to be issued when water level is falling to minor flood level and no further upstream rises are expected.

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Flood Watches

Product ID	Product name	Initiating criteria	Updated	Finalising
IDD20520	Flood Watch – Northern Coastal Rivers	When catchment conditions and forecast rainfall for a flood watch area are expected to lead to flooding within one (1) to four (4) days.	Daily or as required.	When all the catchments within a flood watch area have either moved to a flood warning or are no longer have an expectation of flooding.
IDD20525	Flood Watch – Inland Rivers	When catchment conditions and forecast rainfall for a flood watch area are expected to lead to flooding within one (1) to four (4) days.	Daily or as required.	When all the catchments within a flood watch area have either moved to a flood warning or are no longer have an expectation of flooding.

River height bulletins

Product ID	Product name	Initiating criteria	Updated	Finalising
IDD60022	Northern Territory Rivers	None	Updated hourly.	Never

Rainfall bulletins (1 hourly)

Product ID	Product name	Initiating criteria	Updated	Finalising
IDD60169	North West Top End Catchments	None	Hourly	Never
IDD60170	Arnhem Land Catchments	None	Hourly	Never
IDD60171	Gulf Region Catchments	None	Hourly	Never
IDD60172	Victoria River District Catchments	None	Hourly	Never
IDD60173	Central Australian Catchments.	None	Hourly	Never

Rainfall bulletins (3 hourly)

Product ID	Product name	Initiating criteria	Updated	Finalising
IDD60174	North West Top End Catchments	None	Each three hours	Never

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Product ID	Product name	Initiating criteria	Updated	Finalising
IDD60175	Arnhem Land Catchments	None	Each three hours	Never
IDD60176	Gulf Region Catchments	None	Each three hours	Never
IDD60177	Victoria River District Catchments	None	Each three hours	Never
IDD60178	Central Australian Catchments	None	Each three hours	Never

Rainfall bulletins (24 hourly)

Product ID	Product name	Initiating criteria	Updated	Finalising
IDD60179	North West Top End Catchments	None	Hourly	Never
Product ID	Product name	Initiating criteria	Updated	Finalising
IDD60180	Arnhem Land Catchments	None	Hourly	Never
IDD60181	Gulf Region Catchments	None	Hourly	Never
IDD60182	Victoria River District Catchments	None	Hourly	Never
IDD60183	Central Australian Catchments	None	Hourly	Never

Rainfall bulletins (Daily)

Product ID	Product name	Initiating criteria	Updated	Finalising
IDD10920	Daily Rainfall Bulletin for NT	None	Daily	Never

Rainfall bulletins (Weekly)

Product ID	Product name	Initiating criteria	Updated	Finalising
IDD10940	Weekly rainfall Bulletin for NT	None	Weekly	Never

Schedule 11: List of changes to this Service Level Specification

Version	Date	Name	Update
1.0	20 th May 2014	Nicole Pana	Version 1.0 signed
2.0	March 2015	Nicole Pana	Additional sentence to clause 1.6 highlighting supplementary services
			Addition of priorities to stations in schedules 2-4 and 7-9. This is defined in clause 3.3.2 and Table 1 which are also new additions.
			The addition of flood watch products to schedule 10. This is also defined in clause 3.7 which has also been updated since the 2013 SLS.
			Quantitative and Qualitative clauses better described (3.8.3 and 3.8.4)

Appendix A: Glossary of terms

A.1. General

Bureau Flood Warning Centre: an operational area set aside in each capital city to fulfil the Bureau's role in the Total Flood Warning System specifically flood forecasting and warning.

Bureau National Operations Centre: The principal role of the National Operations Centre is to augment regional flood forecasting teams during major floods and to provide operational system support. The National Operations Centre is also responsible for leading new initiatives to enhance the quality of operations and services.

Catchment Directive: A catchment directive provides guidance specific to a catchment to help develop forecasting and warning products.

Flood warning: A written product to provide advice on impending flooding so people can take action to minimise its negative impact. This will involve some people taking action on their own behalf and others doing so as part of agency responsibilities.

Flood watch: A written product that alerts when the combination of forecast rainfall and catchment conditions indicates the flooding is likely.

National Crisis Coordination Centre: The Australian Government Crisis Coordination Centre has been designed to connect relevant Australian Government, State and Territory agencies to centralise Australian Government actions during complex national crises, to develop a single, timely and consistent picture or understanding of a crisis, its implications and the national capacity to respond.

National Flood Warning Arrangements: The National Arrangements outline the general roles and responsibilities of each level of Government in providing and supporting an effective flood warning service and includes separate chapters describing the specific arrangements and agency roles that apply in each jurisdiction.

Protective behaviour: generating appropriate and timely actions and behaviours from the agencies involved and from the threatened community.

Severe Thunderstorm: A thunderstorm is characterised by sudden electrical discharges, each manifested by a flash of light (lightning) and a sharp rumbling sound. Thunderstorms are associated with convective clouds (cumulonimbus) and are usually accompanied by precipitation. Thunderstorms are often short-lived and impact on only a small area. Severe thunderstorms may last for an hour or more and can have a more widespread impact.

A severe thunderstorm will also have one or more of the following phenomena:

- Tornado
- Wind gust of 90 km/h (49 knots) or more
- Hailstones with diameter of 2 cm or larger
- Very heavy rain sufficient to cause flash flooding

Weather warnings: Weather warnings are messages sent out by the Bureau to warn the community of potentially hazardous or dangerous weather conditions. Such warnings include but are not limited to: road weather alerts, severe thunderstorm warnings, severe weather warnings for heavy rain, strong or gale force winds, marine wind warnings, warnings for sheep graziers and frost warnings. More information on weather terms is given in the [Bureau's glossary](#).

A.2. The components of the Total Flood Warning System

Based on the Manual 21 Australian Emergency Manual Series, Australian Government 2009 (see the Manual for more details).

Communication: disseminating warning information in a timely fashion to people and organisations likely to be affected by the flood (see Chapter 6).

Interpretation: identifying in advance the impacts of the predicted flood levels on communities at risk (see Chapter 4).

Message construction: devising the content of the message which will warn people of impending flooding (see Chapter 5).

Monitoring and prediction: detecting environmental conditions that lead to flooding, and predicting river levels during the flood (see Chapter 3),

Review: examining the various aspects of the system with a view to improving its performance (see Chapter 7).

A.3 Flood classifications

The classification of minor, moderate and major flood levels at key river height stations is based upon the effect of flooding for some distance upstream and downstream of that station. These levels are determined using the following descriptive categories of flooding, historical data or relevant local information.

The process for establishing flood class levels involves determining local flood effects, review and endorsement by relevant stakeholders and passing recommendations to the Bureau for inclusion in forecast and warning procedures. The process for establishment of flood class levels specific to each State and Territory is documented in the National Arrangements.

- Minor flooding - Causes inconvenience. Low-lying areas next to watercourses are inundated. Minor roads may be closed and low-level bridges submerged. In urban areas inundation may affect some backyards and buildings below the floor level as well as bicycle and pedestrian paths. In rural areas removal of stock and equipment may be required.
- Moderate flooding - In addition to the above, the area of inundation is more substantial. Main traffic routes may be affected. Some buildings may be affected above the floor level. Evacuation of flood affected areas may be required. In rural areas removal of stock is required.
- Major flooding - In addition to the above, extensive rural areas and/or urban areas are inundated. Many buildings may be affected above the floor level. Properties and towns are likely to be isolated and major rail and traffic routes closed. Evacuation of flood affected areas may be required. Utility services may be impacted.

Appendix B: References

1. Emergency Management Australia 2009, *Flood Warning Manual*, Series 21.
2. Bureau of Meteorology 2013, *National Flood Warning Arrangements*
3. Bureau of Meteorology 2013, *National Flood Directive* (unpublished - internal use)
4. Bureau of Meteorology 2013, *Catchment Flood Directives* (unpublished - internal use)
5. Data Sharing Agreements